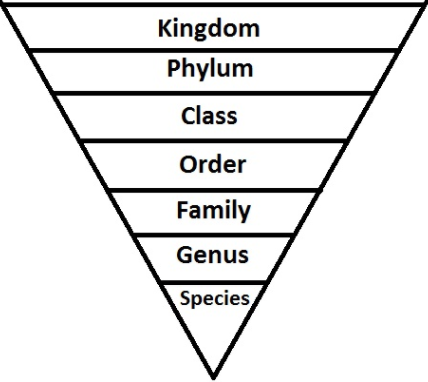
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**Unit 8, Part 4 Notes: Classification**

Pre-AP Biology, Mrs. Krouse

**1. What is classification?**

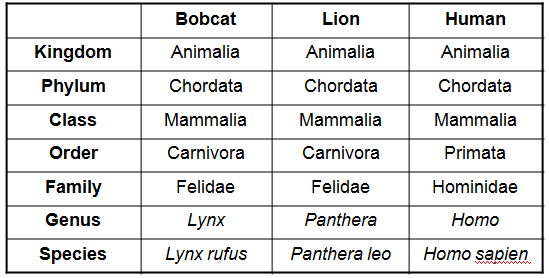
1. For biologists, **classification** is the process of placing organisms into groups based on their similarities. The science of classifying organisms is called **taxonomy**.

1. Traditionally, scientists have placed organisms into groups based on their **morphological similarities**. Morphological similarities are similarities in body structures.
2. Today, scientists typically use **biochemical similarities** between organisms to place them into groups. Biochemical similarities are similarities in the nitrogen base sequences in DNA or RNA or the amino acid sequences in proteins.
3. The scientist who developed the framework for our modern system of classification was **Carolus Linnaeus.**
4. Linnaeus’s system involved placing organisms into groups representing different levels of relatedness. His first level, the kingdom level includes organisms that may be closely related but also may only be distantly related. Linnaeus grouped organisms into two kingdoms—plantae and animalia. Humans and jellyfish are both in kingdom animalia, though we are only distantly related to one another. We are, however, more closely related to each other than we are organisms in kingdom plantae such as dandelions.
5. Linnaeus’s final level, the species level, includes organisms that are very closely related to each other. Remember, according to the biological species concept, members of a species must be able to mate with one another and produce viable, fertile offspring.
6. Linnaeus’s levels, in order from most broad to most narrow, are as follows: **Kingdom, Phylum, Class, Order, Family, Genus,** and **Species**. You can remember the order of these levels using the following memory trick: King Phillip Came Over For Good Spaghetti.
7. Linnaeus also devised a system for giving organisms **scientific names**. This system is called **binomial nomenclature**. “Bi” means “two” and “nom” means “name.” The two “names” are the organism’s genus and species names. For example, the scientific name for humans is *Homo sapiens.* “Homo” is our genus name and “sapiens” is our species name.

*Note: A genus includes a group of similar species.*

1. A scientific name is typically *italicized* or underlined. Often, the genus name is simply abbreviated with its first letter. For example, *Felis domesticus* (the domestic cat) can be abbreviated *F. domesticus.*
2. Scientific names are typically written in Latin. Unlike common names, scientific names are the same anywhere in the world. For example, in America, the common name for *Canis familiaris* is “dog.” In France, the common name for *Canis familiaris* is “chien.”
3. Since Linnaeus devised his system of levels of relatedness and his system of binomial nomenclature, scientists have added a more narrow level. This level is called “**variety**” for plants and “**sub-species**” for animals. Organisms in different varieties or subspecies can still interbreed and produce viable, fertile offspring but may have evolved some different features. For example, there are six varieties of the common box turtle. One of these varieties has three toes on each back foot and is therefore called *Terrapene carolina triungui.* Notice we have added a third name to its scientific name to represent its subspecies.

***Practice Question #1:*** The chart below shows Linnaeus’s levels for bobcats, lions, and humans. Based on the information in the chart, how do you know that bobcats and lions are more closely related than bobcats are to humans?



**2. How have we expanded upon Linnaeus’s system of classification in more recent years?**

1. Remember, Linnaeus only described two kingdoms of living organisms—plants and animals. Today, scientists recognize six kingdoms of living organisms. These kingdoms are listed in the chart on the next two pages along with information about the organisms found in each kingdom.
2. The final column titled “**Domain**” is included because a scientist named Carl Woese compared **ribosomal RNA** sequences for organisms within the six kingdoms. He found that the sequences of all eukaryotic organisms (protists, fungi, plants, and animals) were too similar for these organisms to be placed in four separate kingdoms. Instead, he defined a larger group called “**Domain Eukarya**” into which these four kingdoms are placed. He also defined a domain to include organisms from Kingdom Archaebacteria. He called this group “**Domain Archaea**.” He also defined a final domain to include organisms from Kingdom Eubacteria. He called this group “**Domain Bacteria**.”

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Kingdom** | **# of Cells** | **Cell Type** | **Nutrition** | **Examples** | **Domain** |
| Archaebacteria | Unicellular | Prokaryotic | Autotrophs or Heterotrophs | Typically live in very extreme environments… for example, three types of archaebacteria are:  1. Thermophiles (live in habitats that are extremely hot like geysers)  2. Halophiles (live in habitats that are extremely salty)  3. Acidophiles (live in habitats that are extremely acidic) | Archaea |
| Eubacteria | Unicellular | Prokaryotic | Autotrophs or Heterotrophs | Do not typically live in extreme environments  Specific examples of Eubacteria include:  1. *Streptococcus* (causes strep throat)  2. *Staphylococcus* (causes staph infections)  3. *E. coli* (bacteria that live in your intestines and help you digest food) | Bacteria |
| Protista | Mostly unicellular | Eukaryotic | Autotrophs or heterotrophs | Examples of protists include:  1. Amoebas  2. Paramecia  3. Kelp (multicellular) | Eukarya |
| Fungi | Mostly multicellular | Eukaryotic | Heterotrophs (use external digestion where they secrete digestive enzymes onto their food source and then absorb the nutrients broken down by the enzymes into their bodies) | Examples of fungi include:  1. Mushrooms  2. Puffballs  3. Rusts  4. Molds  5. Mildews  6. Yeasts (unicellular) | Eukarya |
| Plantae | Multicellular | Eukaryotic | Autotrophs  (use photosynthesis) | Examples of plants include:  1. Mosses  2. Evergreen trees  3. Flowering plants (ex: daisies) | Eukarya |
| Animalia | Multicellular | Eukaryotic | Heterotrophs | Examples of animals include:  1. Jellyfish  2. Insects  3. Amphibians  4. Sponges | Eukarya |

***Practice Question #2:*** Define the following terms used in the chart above.

1. Unicellular:
2. Multicellular:
3. Prokaryotic:
4. Eukaryotic:
5. Autotrophic:
6. Heterotrophic:

***Practice Question #3:*** For each of the organisms described below, identify the kingdom to which they belong and explain your choice.

A. The Dendroaspis polylepis is the largest of its kind, can grow to 14 feet, and is considered to be very poisonous. It is a skillful hunter, using its venom and strong muscles to kill its prey.

Kingdom:

Reasons:

B. The Phyllostachys nigra can grow to 35 feet and is found in tropical regions of the world. Despite its inability to move from place to place, it has well-designed organ systems to create its own nutrients and to transport those nutrients.

Kingdom:

Reasons:

C. The Ornithorhynchus anatinus is a very strange organism both in appearance and behavior. It has special organs that allow it to sense the electrical impulses of its prey and attack.

Kingdom:

Reasons:

D. The Paramecium caudatum is a unicellular organism that has a membrane-bound nucleus. It has special hair-like projections called cilia that it uses for locomotion and to capture food.

Kingdom:

Reasons:

E. The Streptococcus pyogenes is a single cell organism that lacks a true nucleus. It is commonly found throughout the world and is a major cause of human sickness.

Kingdom:

Reasons:

F. The Amanita muscaria is a poisonous multicellular organism. Despite its inability to move from place to place, it is able to steal nutrients from dead and decaying organisms in its environment.

Kingdom:

Reasons:

G. The Haloarcula hispanica is a single celled organism with no nucleus found in the hypersaline (super salty!) waters of southeastern Australia.

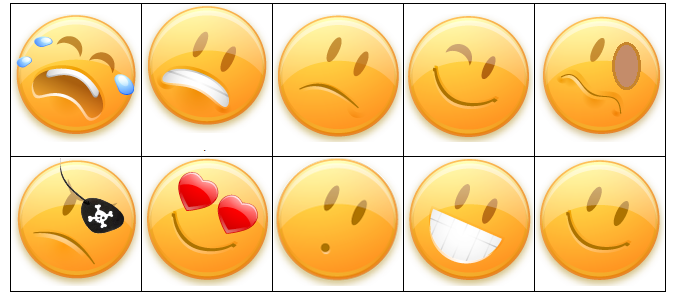
Kingdom:

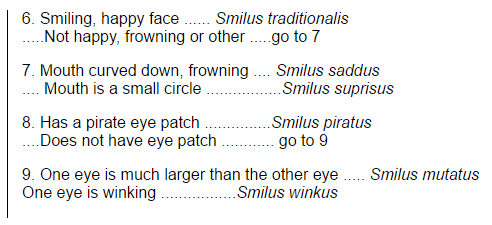
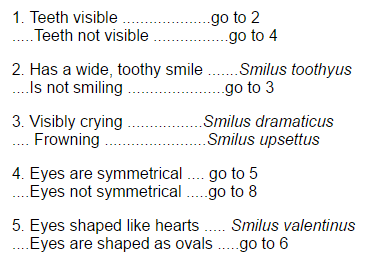
Reasons:

**3. What tools have scientists developed to help us identify organisms as belonging to particular species?**

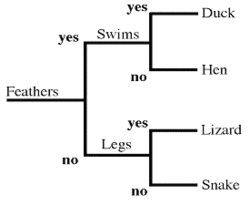
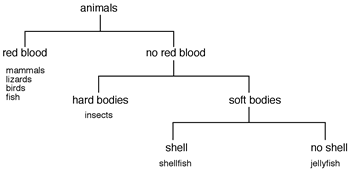
1. Scientists have created tools called **dichotomous keys** to help us identify organisms as belonging to particular species based on their physical characteristics.
2. There are two types of dichotomous keys—lists and diagrams.
3. We will explore lists first. When using this type of dichotomous key, ALWAYS start at #1 in the list. #1 will give you two choices (A and B). You will choose the option that best describes the physical characteristics of the organism you are trying to identify.
4. Based on the option you choose (A or B), you will be told to continue on to another numbered step in the list. Eventually, you will reach a step where the key identifies the species that your organism belongs to.

***Practice Question #4:*** Using the dichotomous key given below, identify the scientific names of all 10 smiley face species shown (Thank you to the creator of Biology Corner for this activity!)





1. Instead of a list, scientists may use a branching diagram to represent the choice made in a dichotomous key. Two examples are given in the space below.

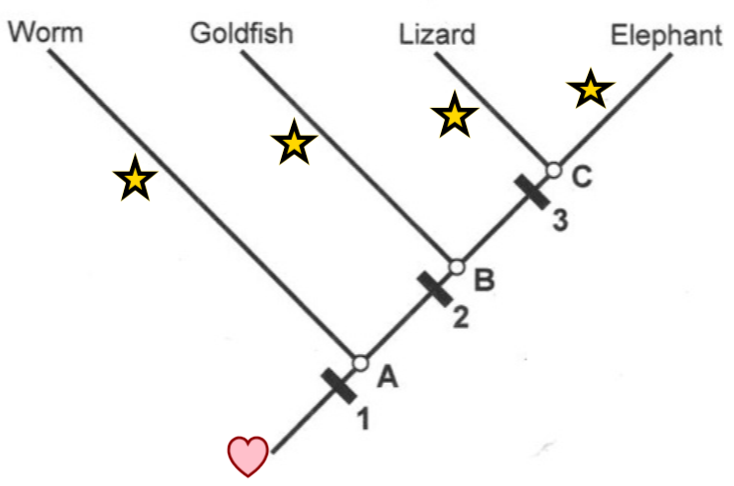
 

**4. What tools have scientists developed to show the evolutionary relationships between groups of organisms.**

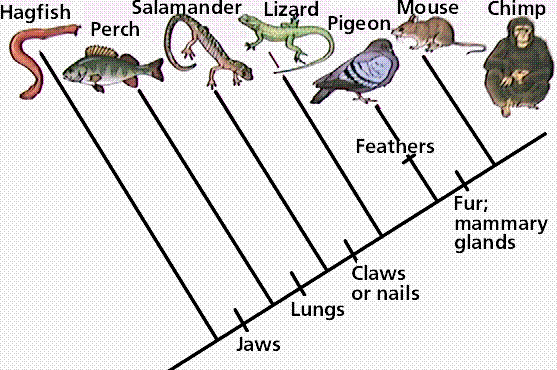
1. Scientists use **cladograms** and **phylogenetic trees** to show evolutionary relationships between groups of organisms.
2. An example of a cladogram is given below.
3. In the cladogram, the heart symbol at the bottom sits next to the **root** of the tree. This root represents the **common ancestor** of all the groups of organisms depicted in the cladogram.
4. The star symbols sit next to the **branches** of the tree. The **tips** of these branches are labeled with the names of specific groups of organisms.
5. The letters A, B, and C sit next to the **nodes** or branching points of the cladogram. These nodes represent points where groups of organisms diverged from one another. For example, Node C represents a point where the groups of organisms that eventually evolved into modern lizards and elephants diverged (branched) from one another. We can also say that Node C represents the common ancestor of lizards and elephants (but not goldfish and worms.)
6. The number 1 sits next to a mark on the main line of the cladogram. We call this mark a “**tick mark**.” This particular mark represents a trait found in all of the groups of organisms shown in the cladogram (worms, goldfish, lizards, and elephants) because it comes before they branched apart from one another. For example, the trait represented by Tick Mark 1 might be cells because worms, goldfish, lizards, and elephants all have cells. We can call this trait a “**shared ancestral trait**” because it was found in the ancestor of all the groups of organisms shown in the cladogram and is still found in all the groups of organisms today.
7. Tick marks 2 and 3 are not shared ancestral traits because they are not found in all the groups of organisms shown on the cladogram. As a general rule…

* The groups of organisms that DO display a particular trait are found ABOVE the trait’s tick mark on the main line of the cladogram.
* The groups of organisms that do NOT display a particular trait are found BELOW the trait’s tick mark on the main line of the cladogram.
* For this cladogram, the trait represented by Tick mark 2 is found in goldfish, lizards, and elephants but not in worms. An example of such a trait might be the presence of limbs.
* For this cladogram, the trait represented by Tick mark 3 is found in lizards and elephants but not in worms or goldfish. An example of such a trait might be lungs.

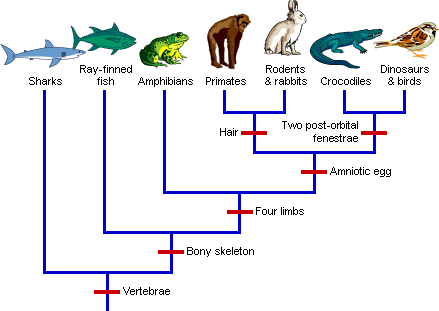
For this cladogram, tick marks 2 and 3 represent traits known as **shared derived traits** or just **derived traits**. They may be shared by some groups of organisms on the cladogram and they are “derived” because they are not found in the common ancestor of all the groups of organisms in the cladogram. These traits arose by mutation later on in certain groups of organisms.



1. Another example of a cladogram is given below. In this cladogram, the tick mark for one of the derived traits (feathers) is placed on a branch rather than the main line of the cladogram. This means that the trait (feathers) is only found in the group of organisms found on that branch (pigeons).



1. A cladogram can also be depicted as shown in the image given below.



1. For this class, you will need to be able to analyze a cladogram. We will practice this in Practice Question #5 given below. For this class, you will also need to be able to create a cladogram for groups of organisms based on shared ancestral traits and derived traits. We will practice this in our Animal Cracker Cladogram Activity.

***Practice Question #5:*** For the cladogram given below c), answer the following questions.

1. Which animal does not have jaws? How do you know based on the cladogram?
2. Which animals have claws or nails? How do you know based on the cladogram?
3. Are pigeons more closely related to mice or perch? How do you know based on the cladogram? Use the term “recent common ancestor” in your answer.
4. **Phylogenetic trees** are another type of diagram that scientists use to represent evolutionary relationships among groups of organisms. They only differ from cladograms in that the length of the branches in phylogenetic trees represents the amount of time that has passed and the amount of evolutionary change that has occurred in groups of organisms. An example of a phylogenetic tree is given below.

